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INCLUDING PRESTRESSED CONCRETE

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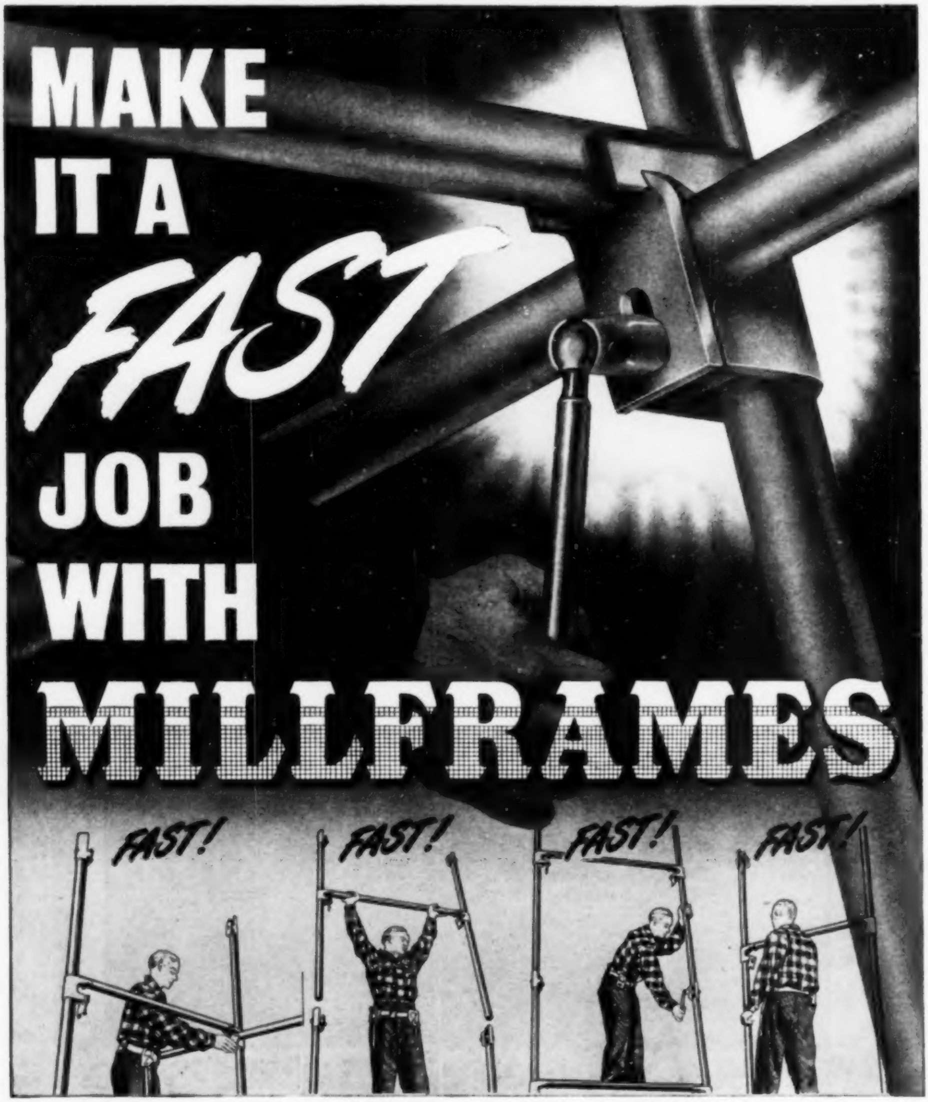

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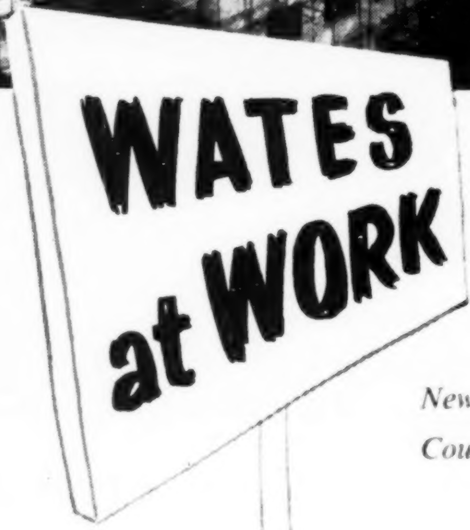
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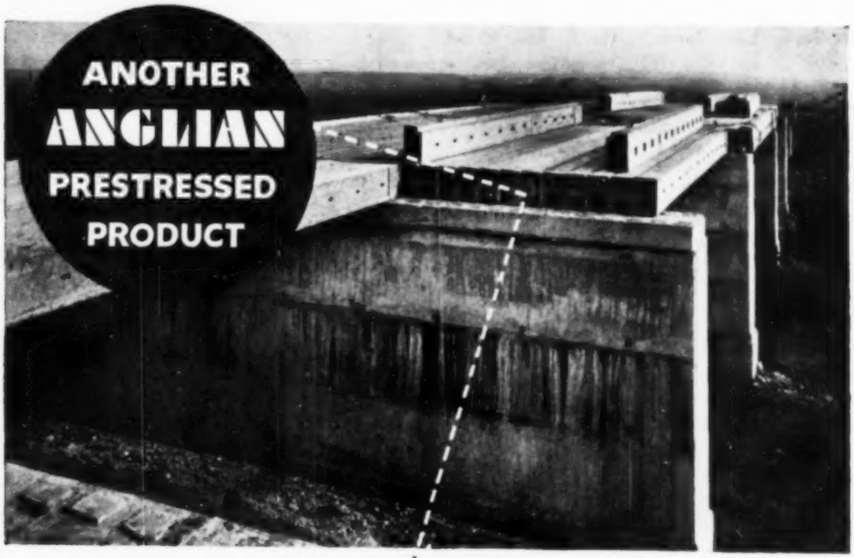

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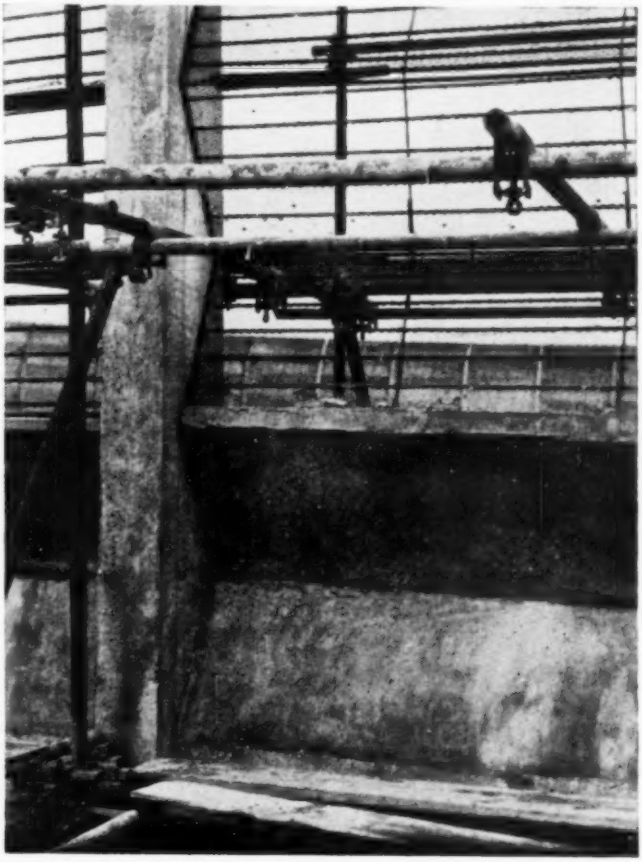

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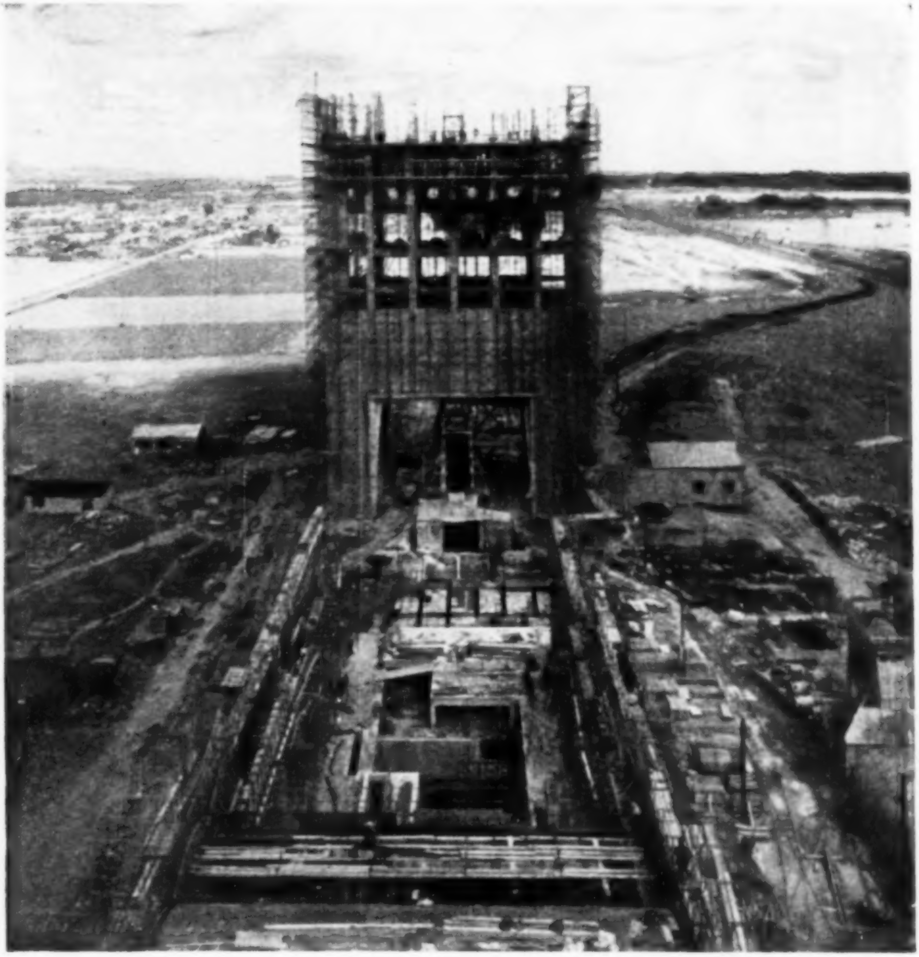

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EDITORIAL NOTES

A Book by M. Le Corbusier.

THE ideas of the French architect M. Le Corbusier have invariably aroused enthusiastic praise or hearty condemnation. The Unité d'Habitation de Marseille is no exception. This immense structure (which is illustrated on pages 300 and 301) contains 337 flats, shops, an hotel of eighteen rooms, a nursery, and a kindergarten, and there are a swimming pool and a gymnasium on the roof. The building is 450 ft. long by 80 ft. wide by 180 ft. high, and has accommodation for 1,500 people. It is supported at about 25 ft. above the ground by reinforced concrete piers which carry the seventeen stories. Along the middle of every other story is a corridor, called a street, served by lifts. The entire building is of reinforced concrete. This structure is briefly described in a recently published book,* from which our illustrations are taken. Architects will be profoundly interested in the planning of the flats and of the building as a complete community, but there is little of interest to the structural engineer; it is indeed a pity that so much of the book is devoted to controversy with those who have criticised the author's ideas on how people should live and so little to technical details of the construction.

In the design of this great structure there are two predominating ideas. The first is that people should live in immense blocks of flats built in the open country, with facilities for shopping and sport within, on top, or under the building, and be able to enjoy the countryside; this idea has not, so far as we know, been strongly advocated in the past. The second idea to which great importance is attached is one that has probably been striven for from the days when man first started house-keeping, and that is that the home should be designed and furnished for the greatest convenience and pleasure of the occupants, although ideas of what are conveniences and pleasurable have changed through the centuries. The author has extreme ideas on what is convenient. He likens a home to a bottle, and says that homes, like bottles, should be stored in bins. All bottles containing the same kind of wine are of the same shape, so the author's view is that all homes should be exactly alike. The savings due to the mass production of identical fittings and furnishings must be taken advantage of to the utmost. The structure is also called a box of homes, and the homes are said to be pigeon-holed in this box as shown in the illustration on page 300.

These ideas have naturally been criticised by people who prefer the garden city type of development in which each house has its own garden, as is mostly

* "The Marseilles Block." By Le Corbusier. Translated by Geoffrey Sainsbury. (London: The Harvill Press. Price 21s.)

the case with the new towns and estates on the outskirts of cities in Great Britain. The separate house is described by M. Le Corbusier as a mausoleum, and criticism of the bottle-and-bin idea is called the venomous outpourings of poisonous little scribes. The author describes how he was permitted to build free of all building regulations. The Minister of Reconstruction is quoted as telling him that in this work he would be above the law ; that the architect could innovate to his heart's content and would alone be responsible for the results. He is indeed a remarkable man who can persuade a government to place his building activities above the law, and who so fiercely replies to critics.

Another unusual attribute of M. Le Corbusier seems to be an idea that his work is specially favoured by nature. For example, now that the building is in being he claims that nature has responded to his efforts and laid her hand upon his work. A lesser man might have been content to claim that he had not spoilt the countryside or, at most, in the jargon of the day, that the building harmonised with its surroundings. Over a long period of years the elements will change the hue and texture of most building materials, and often mellow and improve their appearance, but never before have we heard an architect claim that nature has blessed a new building. It is also stated that a " unit of appropriate size " will bring nature down to the human scale, whereas most people would think that the unit of size adopted by an architect affected the scale of the building rather than reduced the size of nature. We are further told that the module adopted has kept the building comely, smiling, graceful and human. There is no doubt that the comeliness of a building is determined by its scale and proportions, but to people with less imagination it may seem preposterous to claim that an inanimate material has human attributes ; it is common to be asked by architectural pundits to believe such an impossibility as a building material expressing itself, but to ask us to imagine that a block of flats is smiling at us is setting a task which we find as difficult as seeing a meaning in pieces of bent wire that are called sculpture. If we may risk being classed with the outpourers of venom, we would say that it is as ridiculous as it is unnecessary to claim that nature has blessed this or any other building, and that we have yet to see a block of flats break into a smile. We are reminded of a sentence in Mazzini's essay on Carlyle : " Genius is . . . the conscious power of the soul of a man rising from amidst his fellow men, believing and calling himself a son of God, an apostle of eternal truth and beauty upon the earth, the privileged worshipper of an ideal as yet concealed from the majority."

M. Le Corbusier is a great architect of international repute who has contributed new ideas to his art. He has been awarded the gold medal of the Royal Institute of British Architects. He has now had the opportunity of embodying in a unique structure his ideas of what is the best way of living. He has produced a fine building, a clever plan, and labour-saving homes for those who like the idea of spending their home life in one of 337 pigeon-holes. But those who think it better that a family should have a separate home on its own plot of ground, and who think that a home should be something more than what the author of this book has called " a machine to live in," are entitled to air their views, and will probably continue to do so, howbeit with less abuse than M. Le Corbusier heaps upon them. It is disappointing to the reader that so much of the book is devoted to a recital of squabbles between the author and those who have disagreed with him.

The Application of Reinforced Concrete to School Buildings—1.

With particular reference to Precast and Prestressed Concrete.

By FELIX J. SAMUELY, B.Sc., A.M.I.C.E.

THERE are certain problems common to a great number of school buildings, although they often vary in detail with the design. During the past few years, on account of various shortages, precast, and especially prestressed, units have been particularly useful, and there is no doubt that even if there were no shortages such constructions would still be of great use. The following is based on experience gained by the writer in the design of the structure of a number of schools, a list of which is given at the end of this article. The most important components of schools are classrooms, dining halls, assembly halls, gymnasia, and workshops, each of which presents special problems.

General Principles of Construction.

In order to get definite experience of certain problems it is necessary to consider alternative methods, but if too many variations were considered at the same time it would be difficult to analyse the problems. However, in all the schools of which the structures were designed by the writer certain principles of construction were kept the same and an analysis is therefore possible. The principles on which all these schools were designed are as follows.

(a) Precast concrete was introduced to a varying degree, but in every instance it was done in such a way that the erection of precast concrete would be carried out without reference to the in-situ concrete work. In other words, all the precast units are either mechanically connected by steelwork or are stable due to their own weight alone. In no case was grouting or in-situ concrete an essential part of the erection of a precast unit.

(b) Nevertheless precast concrete units were invariably used in such a way that general rigidity of the building was obtained by an in-situ topping. The combination of precast concrete with an in-situ topping is sometimes called "composite construction" * and has many advantages. In order to comply with (a) the in-situ concrete was arranged in every case so that it was not part of the general erection scheme.

(c) As precast concrete depends very much for its economy on repetition, parts where repetition did not occur, for example entrance halls, special corners, gable walls, etc., were usually built in-situ. In some instances all repetitive slabs, beams, and columns were precast; in other cases the columns were cast in-situ and only the beams and slabs were precast. Special attention was given to the problem of not mixing precast and in-situ concrete too much; for example, if a non-standard beam had to be cast in-situ and supported by a standard column, the column was constructed in-situ even if all the other identical columns were precast. The reason is that the combination of a precast column with an in-situ beam makes erection extremely difficult. It is the writer's belief, and is borne out by his experience, that the future of precast units depends on a sensible consideration of the method of erection, and that the indiscriminate use of precast and in-situ concrete together can easily lead to uneconomical construction.

* See the writer's lecture to the Institution of Civil Engineers, February 5, 1952.

(d) The lowest unit cost of a precast member is obtained when not fewer than 50 to 100 are made, and beyond this number there is no reduction in cost. The saving is due to the repeated use of the moulds, but it is not very costly to have small variations in units which do not require an increased number of moulds because such variations can be obtained by inserting liners, blocking-pieces, tubes, etc., in a standard mould. For most small units, for example floor slabs and short beams, sufficient repetition can be found in one school, so that there is no need for a standard grid throughout the country. It has even been possible to have, without adding to the cost, two or three grids in the same building and yet have sufficient repetition to make precasting economical. The grids used in these schools, which in every case have been suggested by the architect to meet the requirements of the plan, are 3 ft. $4\frac{1}{2}$ in., 4 ft., 5 ft. 6 in., 6 ft., 6 ft. 8 in., 6 ft. 9 in., 7 ft. 4 in., 7 ft. 6 in., 8 ft., 8 ft. 3 in., 10 ft., 12 ft., and 15 ft.

A greater difficulty arises with main beams because there are far fewer of them, and in a small school it would be difficult to use the minimum number of the same units which would ensure real economy. For general guidance, a school costing about £50,000 would allow one type of main beam to be precast economically, while larger schools would allow of several types. However, special problems arise, even in small schools, when a variety of main beams is required, for example, one for the roof and one for the floor construction. It may also be that classrooms in the same school have not a constant width, while dining halls and possibly gymnasia and assembly halls also present special problems. It was found desirable, therefore, to apply a certain amount of general standardisation to the main beams, and one of the main difficulties was to find standard units which could be used in various cases; these are referred to later under "Prestressed Planks".

(e) There should be no difficulty in lifting heavy precast units for school construction. There is, however, the question of transport to the site. It has been found generally that units up to 40 ft. long can be made in a factory and taken to the site. In the case of prestressed concrete it is the writer's experience that the bonded method is best. However, it has occurred several times that at small extra cost post-tensioned units could be obtained much quicker because they do not depend on prestressing beds being available. In the case of units longer than 40 ft., or of frames with an awkward shape, it is usually better to precast them at the site. In the case of prestressed units it is sometimes possible to precast short parts and post-tension them at the site. In one case only did the question arise of post-tensioning in-situ concrete (see reference to the assembly hall floor at Hatfield School).

Classrooms, Administration Rooms, Drawing Rooms, etc.

Depth of Floor.—These rooms usually require a structural frame for wings of lengths varying from about 30 ft. to several hundred feet. The width of classrooms varies from 20 ft. to 27 ft. In the case of a classroom it may not always be possible to satisfy all the requirements. The standard construction consists of a number of cross-beams on grid lines with a slab spanning parallel to the front of the classroom. In the writer's experience, however, these cross-beams often present great difficulties because (a) they interfere with the arrange-

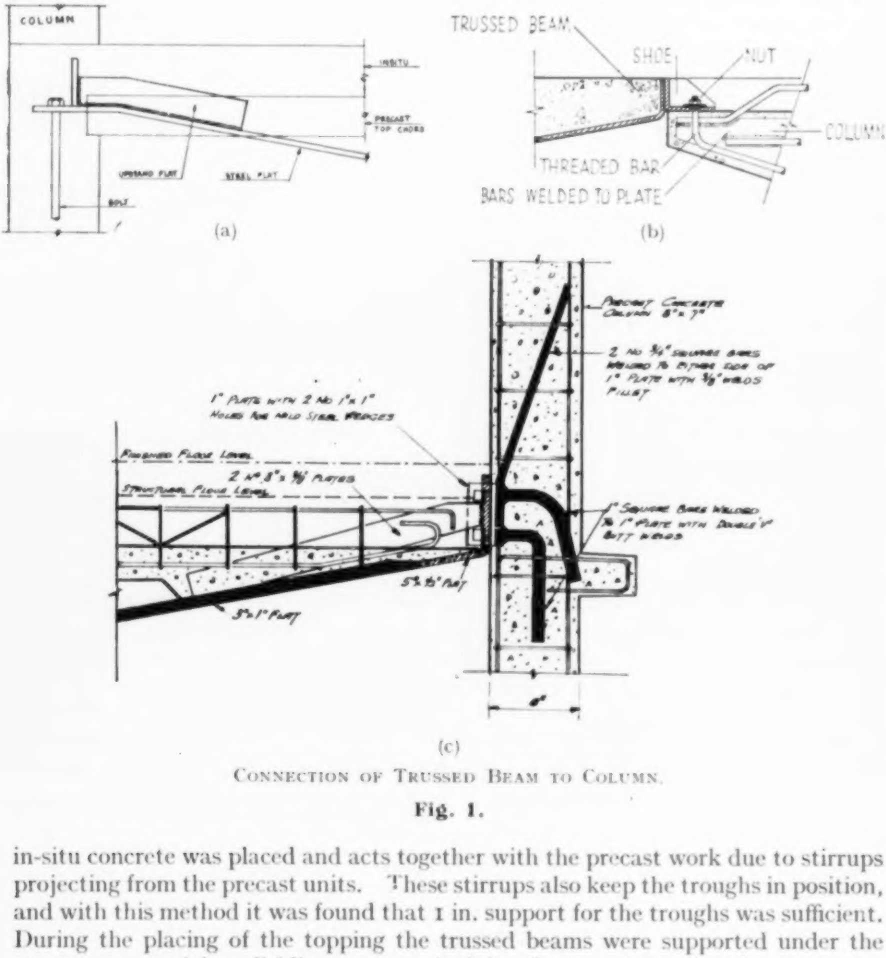
ment of any partition walls, particularly when the beams are latticed, (b) the flexibility is restricted (which is important because of the possibility of changing the plan of the school at a later date), and (c) very frequently the floor-to-floor height of classrooms has to be increased because of the use of deep beams; it has been stated that the apparent necessity of such latticed beams was the reason for the very high classrooms that were at one time requested by the Ministry of Education. While some schools have visible cross-beams, a considerable amount of thought has been given to the problem of avoiding their use altogether and producing a completely flat ceiling which allows the maximum flexibility and gives the greatest amount of headroom.

LIGHTING.—Another important problem is lighting. In order to have good lighting, rooms need a certain height; and the nearer the entry of light is to the ceiling the lower can be the room. For this reason it is better not to have a lintel between the top of the window and the ceiling, and some architects also dislike the shadow created. Sun-blinds are necessary, and apparently no suitable types have been developed which can be pulled up from the sill. The blind, when closed, has to be in a box and this box, if under the ceiling, has the same effect as a lintel. It is therefore desirable to recess the box for the blind in the floor construction. This is simple when the floor spans parallel to the windows and when the beams are not wider than the columns; but if an attempt is made to do away with such beams altogether, or make them shallower but wider than the columns, special difficulties occur.

SLOPING CEILINGS.—Most architects prefer a flat ceiling, but in two cases (Hatfield College and Hatfield Technical School) the requirement was a sloping ceiling which allowed the same amount of light with a much smaller floor-to-ceiling height in the centre of the building and gave an opportunity to use substantial floor trusses and to have the heating installation in the space between the false ceiling and the floor (see Fig. 3, "Concrete and Constructional Engineering," February, 1952). In this case, which incidentally was designed before prestressing was developed so much as it is now, trussed beams are used. The same types of beams are used in the college and in the school, and the number of types was reduced to four. The trussed beam was selected because it was the simplest combination of steel and concrete with no intermediate diagonals, and a flat strip was used for the lower chord because it was easy to bend to the required shape. In the college the columns were precast, but in the school they were cast in-situ. *Fig.* 1 shows the three connections, namely, two (b) and (c) to the precast columns and one (a) to in-situ columns. In the precast columns the plate projects and a slotted plate on the precast beam was fitted over it and fixed by square wedges. The in-situ columns were cast up to the level of the beam-support and the beam fitted over a threaded bar in the column to which it is held by a nut. While the erection was very simple in both cases, the fitting of the projecting plate into the precast column was a very expensive item, particularly as the plate had to be fitted absolutely accurately.

TRUSSED BEAMS.—Trussed beams have been used in others of the schools. In Torells School (*Fig.* 2) a trussed beam was used in combination with precast columns with connections similar to those shown in *Fig.* 1, but in this case the lower chord was left visible. The main difference between these beams and those at Hatfield is that the struts were made of tubes and arranged vertically to suit

the architects' requirements. The position of these struts was very much controlled by the position of the lighting points. The central panel was much longer than at Hatfield, although the overall span was the same; this resulted in a considerably deeper beam over the top chord ($10\frac{1}{2}$ in. instead of $7\frac{1}{2}$ in. overall). In both cases only 3 in. of the top chord are part of the precast units, and troughs were used to span from beam to beam, at 5-ft. 6-in. centres at Hatfield and at 7-ft. 6-in. and 10-ft. centres at Torells (*Fig.* 3). On top and between the troughs



Connection of Trussed Beam to Column.

Fig. 1.

in-situ concrete was placed and acts together with the precast work due to stirrups projecting from the precast units. These stirrups also keep the troughs in position, and with this method it was found that 1 in. support for the troughs was sufficient. During the placing of the topping the trussed beams were supported under the struts; no special scaffolding was required for the troughs, and each trough was strong enough to carry the weight of the wet concrete already placed and of a barrow filled with concrete.

Prestressed Trussed Beams.—When prestressed concrete was further developed the trussed beam lost its attraction for a time. While the great depth that can be achieved with a trussed beam results in a decrease of steel without

increase of concrete and of weight, and in a very light-looking construction, it appeared that prestressing of the lower chord would be difficult due to its cranked shape. Recently the problem has been overcome, and in *Fig.* 4 a trussed beam is shown which is used for several of the schools in Kent—in the first instance at a school at Penge Melvin. In this case the lower chord consists of wires which were post-tensioned by two jacks built into the struts. These jacks produce initial tension only at the factory, and the wires are tensioned at the site to carry the full load. As the wires are kept in tension merely by turning a nut,

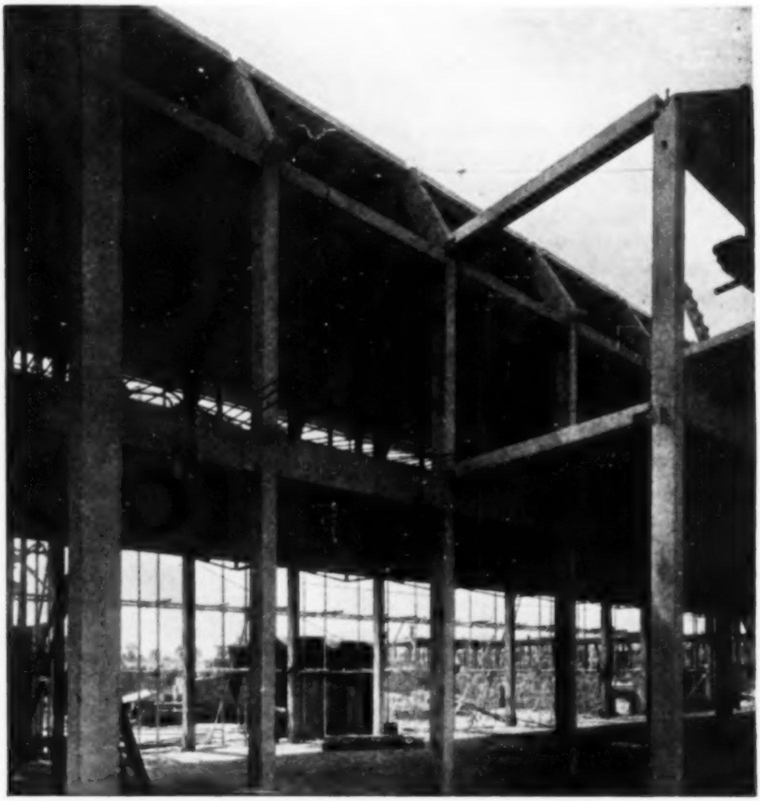


Fig. 2.

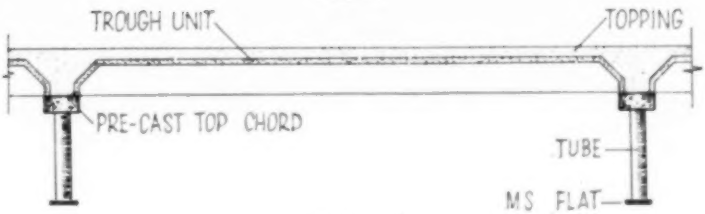
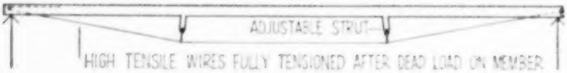
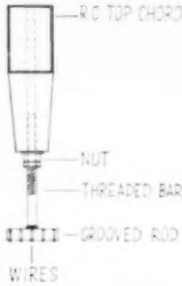


Fig. 3.



TRUSSED BEAM.



DETAIL OF STRUT.

Fig. 4.

and as the force in the strut is only about one-sixth of that in the lower chord, it was possible for the tensioning to be done by two unskilled workmen who prestressed a beam in ten minutes. In this case the beam has an upper chord 4 in. by 6 in. spanning 25 ft. and supports wood-wool slabs only. It was important to reduce the weight of the truss because, with the very small dead and live loads of the roof, the weight of the concrete could have become an important item. The trussed beam, however, weighed less than 30 lb. per linear foot for a total load of about 240 lb. per linear foot.

HOLLOW-TILE FLOORS.—In many classrooms it is desirable to have shallow beams or no beams at all, and the problem of achieving a beamless floor economically is worth considerable thought. In spite of prestressed concrete, the writer has found that hollow-tile floors spanning from front to back of the classrooms are economical and were used at the school at Cubitt Town (*Fig.* 5). With hollow-tile floors with in-situ ends it is feasible even to reduce the thickness at the front and back locally to provide space for a blind-box. This hollow-tile floor had the disadvantage of requiring shuttering and steel, neither of which was readily available at the time. In some schools the writer has used proprietary precast floors, notably at Blackwell Secondary School, Middlesex.

Prestressed Planks.

Due to standardisation, proprietary floors do not lend themselves very easily to such special problems as blind-boxes, etc. The construction then used by the writer on a great number of schools was prestressed beams spaced apart

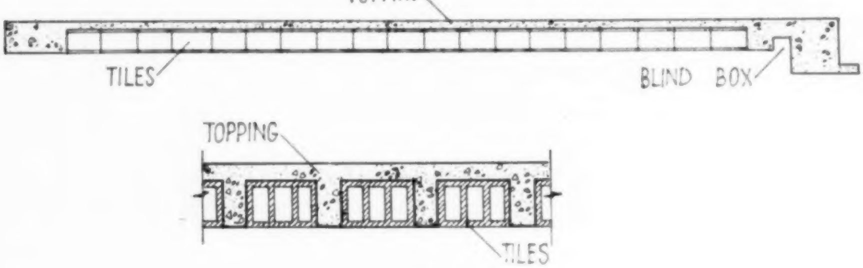


Fig. 5.

with various methods of filling between them. The principal reason was that prestressed concrete could be used more economically than reinforced concrete in shallow beams. While for ordinary reinforced concrete floor beams a depth-to-span ratio of 1 : 16 to 1 : 20 appears to be economical, for prestressed concrete the ratio is nearer 1 : 25 to 1 : 30.

Applying the foregoing to classrooms, which usually have a span of about 24 ft., it is found that a construction depth of about 12 in. is suitable in prestressed concrete and this thickness is not too large for a floor. In other words, prestressed concrete allows a reduction in the depth of beams so that they do not project below the soffit of the floor, although a false ceiling may be required.

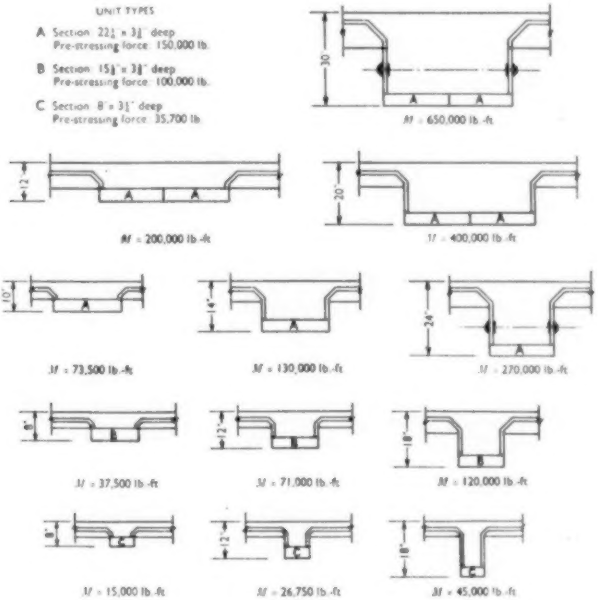


Fig. 6.

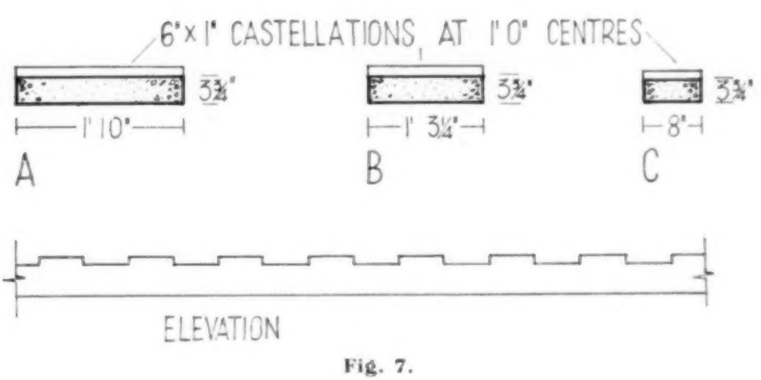


Fig. 7.

The soffits only of the beams were prestressed, partly because this was the most economical way of prestressing, and partly because the top concrete is so much cheaper placed in-situ and at the same time provides a monolithic floor ; also, it was possible in this way to standardise the depth in three types and to use the same three types in all the schools (and other buildings as well), even though the loads, spacings, and lengths differed considerably. This is made clear by *Fig.* 6 which shows the same type of plank being used for a beam having a bending moment of 73,500 ft.-lb. and a beam having a bending moment of 270,000 ft.-lb.

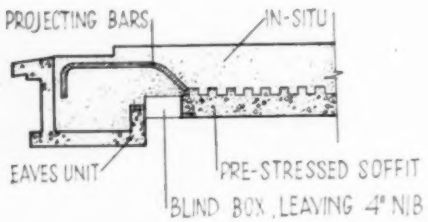


Fig. 8.

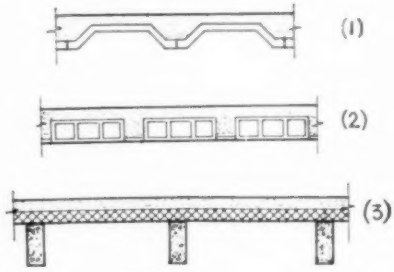


Fig. 9.

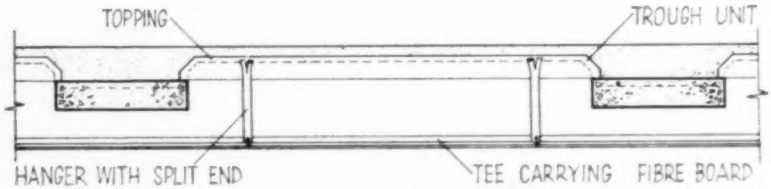


Fig. 10.

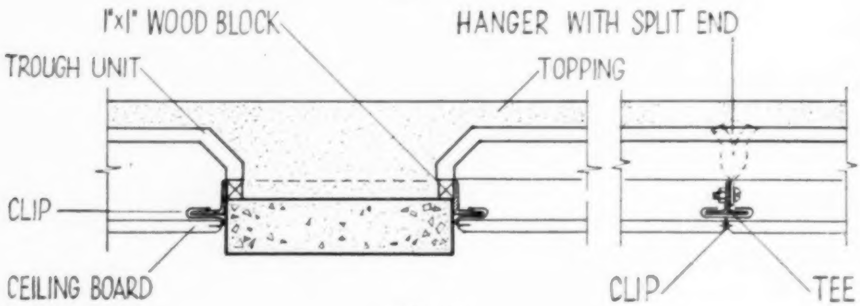


Fig. 11.

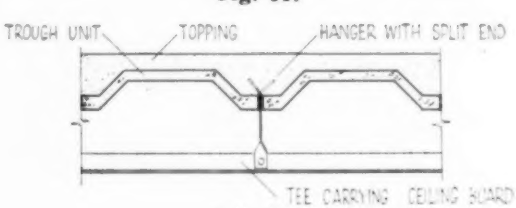


Fig. 12.

The standard soffit members are shown in *Fig.* 7. The rather odd overall dimension in *Fig.* 7 is a result of placing wires in the soffits at definite centres and forming standard holes for fittings.

A special problem that arose with all the schools dealt with in this article was the question of the blind-boxes cutting into the soffits, as the soffits were always wider than the columns. The solution of this problem was easier because the bending moment was naturally very small at the ends of the beams where the blind-boxes occurred and special bars were arranged, projecting from the prestressed unit into the in-situ concrete, to resist shearing forces; *Fig.* 8 shows this method at Paragon Road School.

The greatest difficulty to be overcome was the practical one of how to achieve a flat ceiling. The various solutions for these intermediate floors are shown in *Fig.* 9. Structurally, the most satisfactory solution appeared to be floor-troughs in combination with prestressed units. These troughs, of the same type as those mentioned earlier, were used, for example, at Woodberry Down Comprehensive High School and Wigan Technical College, the gymnasium at Eastcote Lane School, and others. In some cases, for example the changing-

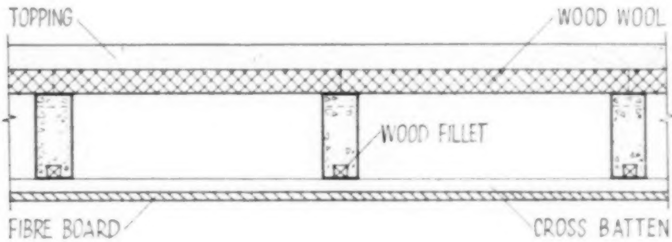


Fig. 13.

rooms at Eastcote Lane School, the architects allowed the coffered ceiling produced by the troughs to be visible, and in these cases the construction is quite satisfactory. Where the architect preferred a flat ceiling, however, a false ceiling was required and additional cost occurred. Such a false ceiling can be arranged either under the soffit to give a true flat ceiling as at Woodberry Down (*Fig.* 10), or immediately under the troughs to give the appearance of wide beams as at Old Palace School (*Fig.* 11). As a false ceiling cannot span from beam to beam it usually has to be hung from the points between the troughs, and in *Figs.* 10 to 12 various methods are shown which have been used to hang the ceiling.

An entirely different method of providing a flat ceiling (at Cottingham School) is shown in *Fig.* 13. In this case concrete ribs were arranged at 2-ft. centres, forming secondary beams. On top of these beams were placed wood-wool slabs spanning between the ribs and a thin concrete slab was cast on top of the wood-wool. This construction forms a grid of 2 ft. only for a false ceiling, and either plasterboard or building-board can be nailed to the ribs, which have a timber fillet inserted for the purpose. Incidentally, these ribs were found to be satisfactory in prestressed concrete only, because it was very difficult in ordinary precast concrete to produce narrow ribs with a timber fillet without considerable breakages at the fillet on the site.

Again, a different construction (*Fig.* 14) was used at Barley Lane School (Essex) among others. Here a hollow floor was arranged with precast concrete units at the bottom fixed to intermediate ribs. The intermediate ribs are similar to those in *Fig.* 13, but were much simpler to make as they do not contain a timber fillet. This construction could be plastered immediately.

An alternative to this construction for roofs is shown in *Fig.* 15. Here precast slabs form the soffit and wood-wool slabs with a concrete screed form the top. A variation of *Fig.* 14 was used at Wigan Secondary Technical School, where the main beams were at 3-ft. 4½-in. centres only, in accordance with the general grid, and therefore it was possible to omit secondary ribs. The lower concrete units were required by the architect to show a special coffering effect (*Fig.* 16), while the upper unit was replaced by corrugated steel covered with in-situ concrete.

Still another construction was used at Paragon Road School, Hackney. In this case the grid was 8 ft. and inverted precast tee-beams were arranged to span this distance, with either wood-wool or corrugated steel sheeting carrying the top in-situ concrete (*Fig.* 17).

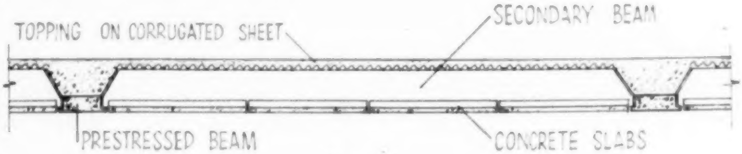


Fig. 14.

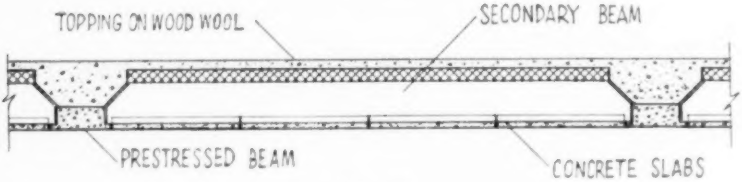


Fig. 15.

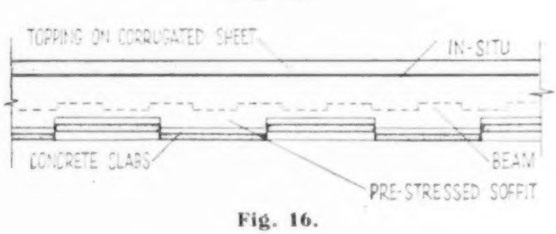


Fig. 16.

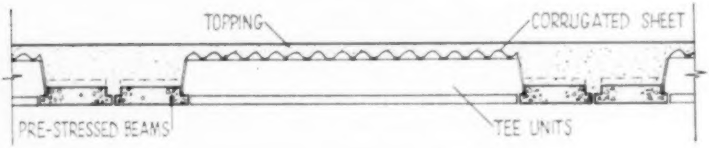


Fig. 17.

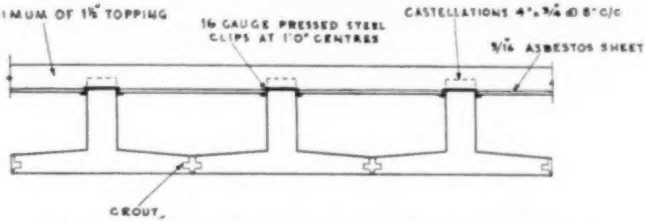


Fig. 18.—Cross Section through Typical Tee-floor.

Each of these constructions appeared to be practicable. None of them was entirely satisfactory insofar as the cost of the intermediate construction was much too high compared with that of the main beams. A further development to overcome this difficulty has been the use of inverted tee-beams together with an in-situ topping cast on permanent shuttering (*Fig.* 18). This is at present being developed and will be used at a number of schools now being built, but as no experience is available a brief description only is given. Floors of the cross section shown in *Fig.* 18 must have a depth of about one-fortieth of the span for normal loads, and can in fact be used for a great variety of spans. Where special loads occur, as for example where cross-walls are to be supported, a stronger floor can be produced by filling the voids with concrete and adding reinforcement near the lower flange. It is generally recommended to form vee-joints between the tee-beams at the bottom and not to plaster them, but alternatively they may have vee-joints at the top which are filled with grout and then plastered on the underside.

Schools referred to

Hatfield Technical College and Hatfield Technical School. Messrs. Easton & Robertson, F.F.R.I.B.A., architects.

Wigan Secondary Technical School and Wigan Technical College. Mr. Howard V. Lobb, C.B.E., F.R.I.B.A., and Mr. Grenfell Baines, F.R.I.B.A., architects.

Cottingham Secondary School. Mr. K. F. Giraud, A.R.I.B.A. (architect of East Riding County Council).

Primary and Infants' School, Old Palace, Poplar. Mr. C. C. Handisyde, A.R.I.B.A., A.A.Dip., architect.

Secondary School, Paragon Road, Hackney. [In conjunction with Mr. F. R. Bullen, B.Sc.(Eng.), M.I.C.E.] Mr. Howard V. Lobb, C.B.E., F.R.I.B.A., architect.

Primary School, Kingsmead, Hackney. Mr. George Fairweather, F.R.I.B.A., architect.

Cubitt Town School. Mr. Howard V. Lobb, C.B.E., F.R.I.B.A., architect.

Roman Catholic School, Tottenham. Messrs. Hiscock & Duncan Scott, architects.

Primary and Infants' School, Valley Hill, Loughton. Messrs. Westwood, Sons & Harrison, architects.

Primary and Secondary School, Barley Lane, Ilford. Messrs. Hiscock & Duncan Scott, architects.

Torells Secondary School, Little Thurrock. Messrs. Westwood, Sons & Harrison, architects.

Primary and Infants' School, Abingdon. Messrs. Bridgwater & Shepheard, architects.

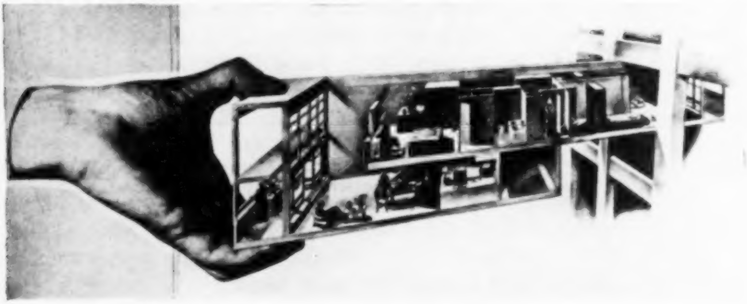
Comprehensive High School, Woodberry Down, Stoke Newington. London County Council Architect's Department.

Secondary School, Eastcote Lane, Middlesex. Middlesex County Council Architect's Department.

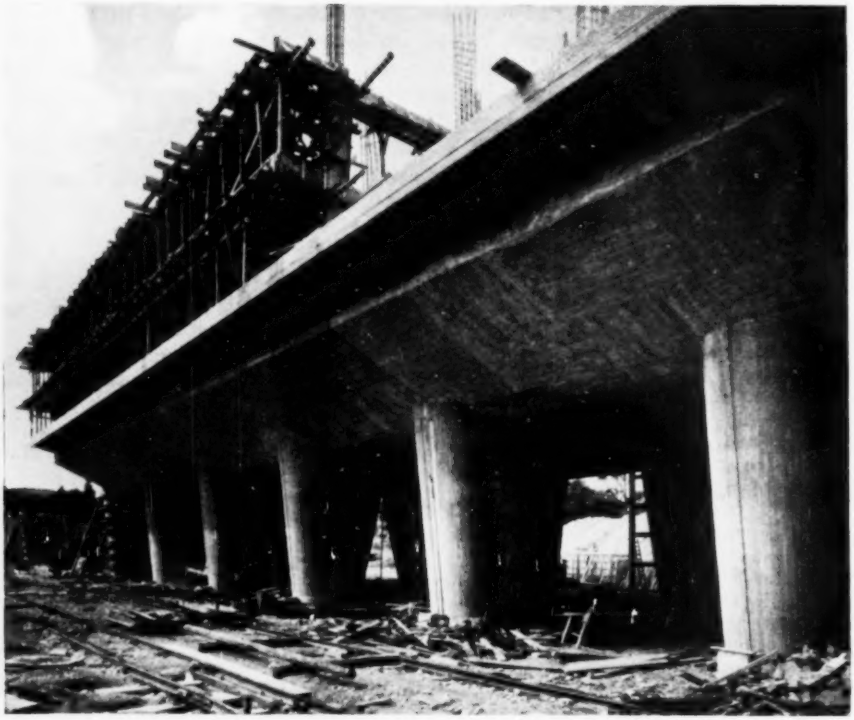
Blackwell Secondary School, Middlesex. John and Elizabeth Eastwick-Field, architects.

Several Primary Schools for Kent County Council. Kent County Council Architect's Department.

(*To be concluded.*)



"THE STANDARD CELL."



From "The Marseilles Block."

THE SUPPORTING PIERS.

A Block of Flats near Marseilles. M. Le Corbusier, Architect.

(See p. 287.)

From "The Marseilles Block."

A Block of Flats near Marseilles. M. Le Corbusier, Architect.

(*See page* 287.)

Book Reviews.

"Prestressed Concrete." By Y. Guyon. (London: "Contractors' Record and Municipal Engineering." 1953. Price £3 10s.)

THIS book of more than 550 pages, first published in Paris in 1951 and now translated into the English language, is confined to the design of simply-supported beams. The text is based on mathematics, frequently of a high order, and includes numerous examples of the work of M. Freyssinet (who contributes a Foreword) and other French engineers. The book also describes a large amount of testing and research work. The various systems of prestressing are described, and methods and materials, with particular reference to the properties of high-tensile steel wire and to the production of concrete with suitable characteristics and of sufficient strength, are discussed. The work is well illustrated and contains numerous diagrams, tables, and references to research, the testing of structures, fire resistance, local stresses in the concrete due to anchorages, and other physical properties. Design is treated in great detail for beams of constant cross section and of variable depth, and the advantages of curved and straight cables are fully discussed and illustrated. Much new matter and information not previously available in book form is included.

The book, while interesting and informative throughout, requires, if it is to be assimilated and appreciated, most careful attention and profound study. It will doubtless be appreciated by many of the younger scientifically-minded engineers who are interested in the subject. The book would not serve as a handbook for quick reference.—R. P. M.

"Concrete Mix Design. A Practical Method for the Production of Quality Concrete from Available Materials." By L. Boyd Mercer. (Melbourne Technical College Press. 1953. Price not stated.)

THE purpose of this book is to present a practical method for producing high-quality concrete. Its principal object is to show how to make the best use of aggregates that may not be well graded, but the method described can be more easily used for suitably-graded aggregates.

The calculations start from the compressive strength used in designing a structure. This strength, when multiplied by a factor of safety, gives a minimum permissible crushing strength. From this a "target" strength is fixed sufficiently high to ensure that a few only of the test pieces have less than a practical minimum strength. A statistical method for doing this is given. This is followed by a description of the commonly-used methods of relating the crushing strength and the cement content to the water-cement ratio, and calculating the proportion of fine to coarse aggregate that gives a combined aggregate having a grading corresponding as closely as possible to a "base" or type-grading curve. The author gives his own base grading curves and makes a feature of showing how to design gap gradings. Using the calculated proportions, a trial mixture is made and if necessary the proportions are changed and another trial mixture is made.

Short chapters deal with the economics of making concrete; the properties and testing of cement; the quality, grading, and specification of aggregates; the relation of grading to compaction, segregation, and proportions; the variations in proportioning, mixing, and testing concrete; and the application of statistical methods to the proportioning of mixtures. The diagrams necessary for the application of the method are given, together with examples.

The book is obviously based on wide experience of aggregates in different countries and of the application in practice of the methods described. The author's outlook is practical, and is based on a sound knowledge of theory and experiment. The book is a readable and concise introduction to the proportioning of concrete mixtures, as well as a clear exposition of a simple, practical, and easily-applied method of making the best use of aggregates that are economically available.—H. N. W.

"Reactions between Aggregates and Cement." National Building Study No. 15. (H.M. Stationery Office. Price 1s.)

THIS is mainly a résumé of the literature on the alkali content of cements and aggregates. The conclusion is reached that there is no risk of deterioration of concrete, due to alkali reaction, in the case of British aggregates except possibly andesite. This is the second National Building Study on this subject, and it is stated that a third is forthcoming.

A Graphical Method of Designing Cylindrical Shells.

By PROFESSOR A. L. L. BAKER, B.Sc., M.Inst.C.E.

THE advantages of the graphical method described in the following are that it gives a quick solution, helps to avoid errors in computation, and enables the designer to visualise the influence on the bending stresses of the shape of the shell and the distribution of load. Moreover, since the ultimate value and distribution of stress in the concrete cannot be precisely determined, and the strength of the concrete is not generally of critical importance, the method may often be sufficiently accurate for practical purposes.

The following assumptions are made, and are acceptable for conditions prior to failure due to longitudinal bending.

(1) The shell spans longitudinally between supports as a beam of hollow cross section subjected to transverse bending.

(2) Concrete has no tensile strength and is assumed to be cracked below the neutral axis in considering the main longitudinal bending stresses, tensile forces being resisted by the main reinforcement at the edges. In some cases advantage may be taken of the resistance to tensile forces of the longitudinal reinforcement between the edges and the neutral axis.

(3) The main longitudinal compressive stresses due to bending are uniformly distributed above the neutral axis along the arc of the cross section (*Fig.* 1*c*). A condition approximating to this occurs before failure can take place by crushing of the concrete.

(4) The longitudinal strain due to longitudinal bending as a hollow beam is proportional to the vertical distance from the neutral axis.

(5) Longitudinal bending stresses in the slab are negligible. This is a safe assumption, and is true when strips of the shell spanning longitudinally are sufficiently flexible relative to strips spanning transversely, due either to their length or to cracking caused by longitudinal bending of the whole shell as a beam.

(6) Torsional resistance of the slab may be ignored. This is a safe assumption and may be necessary since torsional resistance is reduced by cracking.

Considering the shell as a beam of partly cylindrical or polygonal cross section, when calculating the longitudinal bending stresses the position of the neutral axis can be determined in the usual way for reinforced concrete beams from the assumed distributions of stress and strain, and suitable values of E for concrete and steel, by satisfying the conditions that (i) Total compression must equal total tension and (ii) Strain is proportional to the vertical distance from the neutral axis.

The distribution of longitudinal bending stresses determines the distribution of shear in the plane of the slab (sometimes called the "membrane shear") along the edges of a strip such as a, b, c, d (*Fig.* 1*c*). If the tension is concentrated at the edge and the compressive stress is uniform along the arc, then the distribution of membrane shear along the arc will be as shown at (*b*), that is a rectangular distribution below the neutral axis and a triangular distribution above the neutral axis (for a triangular distribution of stress above and below the neutral axis the distribution of membrane shear would be parabolic, and for uncracked sections below the neutral axis such a distribution might be assumed).

The distribution of the difference of membrane shear between two sections such as a–c and b–d (*Fig.* 1*c*) is the same as the distribution of shear at either section, so that a strip such as a, b, c, d in a symmetrical shell symmetrically loaded is kept in equilibrium by forces as shown at (*a*), namely, downward loads P_1 to P_4 on segments such as A–B, B–C, etc., differences of shear across the strip such as S_1, S_2 assumed to act tangentially at the centre of each segment A–B, B–C, etc., and whose value is proportional to the width of the shear-distribution diagram in *Fig.* 1*b* at appropriate points along the arc. The longitudinal bending

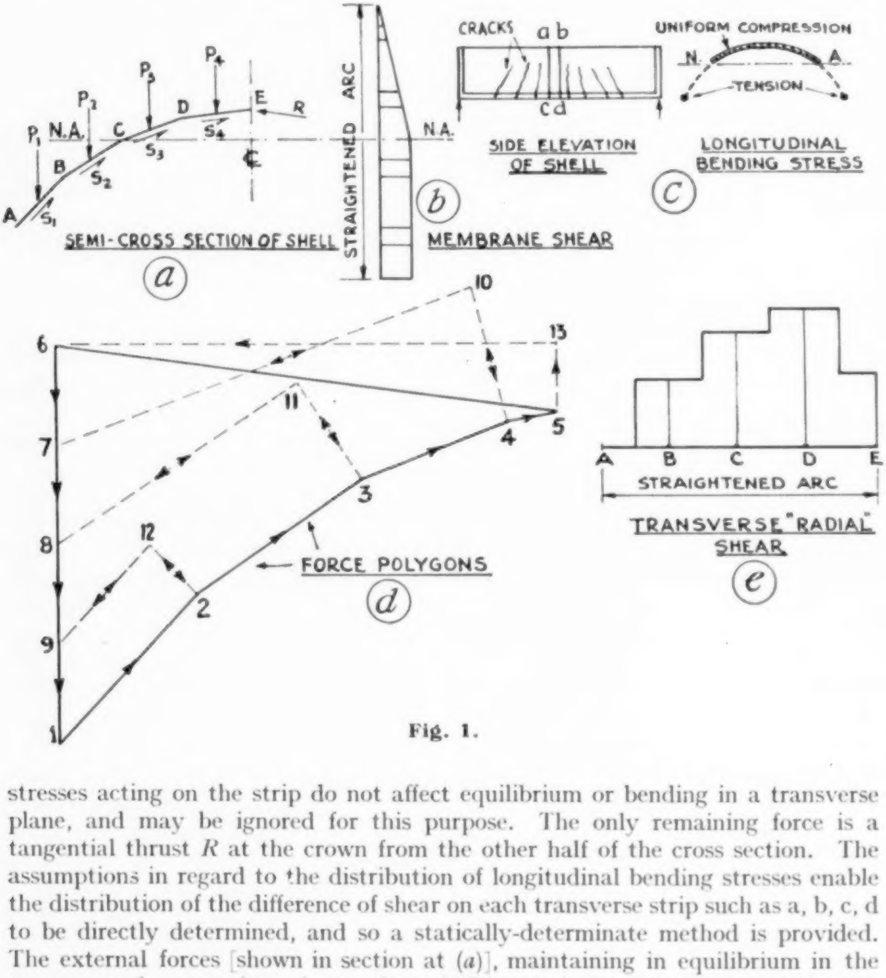


Fig. 1.

stresses acting on the strip do not affect equilibrium or bending in a transverse plane, and may be ignored for this purpose. The only remaining force is a tangential thrust R at the crown from the other half of the cross section. The assumptions in regard to the distribution of longitudinal bending stresses enable the distribution of the difference of shear on each transverse strip such as a, b, c, d to be directly determined, and so a statically-determinate method is provided. The external forces [shown in section at (*a*)], maintaining in equilibrium in the transverse plane a strip such as a, b, c, d (*Fig.* 1*c*), isolated by cuts from the rest of the shell, may be determined vectorially.

In *Fig.* 1*a* vectors 1–2, 2–3, 3–4, and 4–5 are drawn parallel to tangents at the mid-points of segments A–B, B–C, C–D, and D–E, and in length are propor-

tional to the appropriate widths of the shear diagram at (*b*). Vectors 5–6 and 1–6 are drawn parallel to the thrust R and the loads respectively. Vector 1–6 is divided into lengths proportional to the loads, so that 6–7 is the vector for P_4, 7–8 for P_3, and so on. Now vector 1–6 represents the total load on the strip a, b, c, d which may, for convenience, be of unit width. The scale of the polygon of forces is thus determined. If imaginary cuts are made at B, C, and D, and the internal forces thus removed are replaced by equal and opposite external forces, the forces keeping the segments A–B, B–C, etc., in equilibrium in a transverse plane may be determined. At each cut it is necessary to apply equal and opposite radial shear forces and circumferential thrusts acting on the segments on each side of the cut. Force polygons may be drawn for each segment. Starting with segment D–E, vectors 7–10 and 4–10 are drawn parallel to C–D and a radius through D respectively. Vectors 7–10 and 4–10 then represent to scale the thrust and radial shear from segment C–D acting on segment D–E. Vectors 8–11 and 11–3 are drawn parallel to B–C and a radius through C and represent thrust and radial shear forces from segment B–C acting on segment C–D. The polygon of forces for segment C–D is therefore 7–8–11–3–4–10. Similarly, 8–9–12–2–3–11 is the polygon of forces for B–C, and 9–1–2–12 the polygon of forces for A–B, 9–12 being parallel to A–B and 2–12 parallel to a radius through B. The force R is resolved into radial and horizontal components represented by vectors 5–13 and 13–6, the latter being the value of the radial shear in segment D–E between the mid-point and the crown. The circumferential thrusts and radial shears in the transverse strip can now be scaled from the force diagram. The latter may be plotted on the straightened arc as shown at (*e*) ignoring the radial components of the thrusts and assuming the shear to be normal between the mid-points and equal in value to the radial shear between the segments. The transverse bending moment in the transverse strip at any section is equal to the area of the shear diagram to the left of the section. The maximum bending moment is at E and is equal to the area of the whole diagram.

The distribution of shear, transverse bending, and transverse thrust may be investigated in this way at any cross section. Close to the supports the concrete may be uncracked, but the same procedure can be followed except that the shear distribution below the neutral axis is assumed to be parabolic. A small number of segments has been used for clarity; greater accuracy is obviously obtained if the transverse strip is divided into a greater number of segments, but such accuracy is not so important as investigating possible positions of the neutral axis and distributions of load for extreme conditions. Values of transverse bending-moments are sensitive to changes of membrane shear distribution. It is therefore more important to consider variations of this influence than to be fastidiously accurate in calculating the bending and shear stresses from values which are themselves only approximate.

The method can be applied to any shape of cylindrical or prismoidal shell in which the distribution of longitudinal bending stresses, after cracking and prior to failure, approximates to that of a beam of hollow section. An edge-beam when cracked may be considered as part of the section of the shell. The vertical upward shearing forces at the edge may produce near the edge transverse " radial " shearing forces of opposite sign to those over the inner part of the shell, thus producing a reversal of bending moment. A similar condition may occur when

the load is concentrated close to the crown. Since the value of the downward transverse bending moments due to the load depends only on the value and position of the loads, when the bending moments due to load are greater than the upward bending moments due to shear the resultant transverse bending moments will be greatest when the bending moments due to shear are lowest, that is when the neutral axis is at the highest possible position so that the difference of shear stresses is a minimum.

Cantilevered Shuttering for Bridges.

In our August number a prestressed bridge at Worms, Germany, the spans of which were built with the aid of cantilevered shuttering and without staging, was described.

It may be mentioned that cantilevered shuttering was used in Britain for the construction of the river span, 150 ft. long, of a bridge at Aveley, over the river Severn, in the year 1936. Two side spans of 60 ft. served to counterweigh the central span during construction. The reinforcement was in 15-ft. lengths and the splices were staggered in groups at 5-ft. intervals, enabling 5 ft. of the bridge to be constructed at a time. No elaborate plant was used. There was a trolley on each cantilever from which the shuttering was suspended, but the greater part of the weight of the concrete was carried by the shuttering cantilevered off the fixed shuttering behind. The suspended platform consisted of scaffold boards resting on the rungs of ladders hanging from the top. The cableway for moving the concrete and other materials was a discarded colliery rope suspended between trees on either side of the river, the motive power consisting of an old motor-car with the haulage rope passing around one of the back wheels from which the tyre was removed. A photograph of this work during construction is given above.

This work was fully described by Mr. A. P. Mason, B.Sc., M.I.C.E., and illustrated in "Concrete and Constructional Engineering" for August, 1937. The engineers were the British Reinforced Concrete Engineering Co., Ltd., and the contractors Messrs. Thomas Beighton, Ltd.

The Measurement of Humidity.

Humidity of the atmosphere has to be controlled in many places and for many manufacturing processes, and a recent publication of the National Physical Laboratory, "Notes on Applied Science, No. 4—Measurement of Humidity" (H.M. Stationery Office. Price 1s.), outlines methods of measuring the moisture content of the air. The pamphlet describes the types of hygrometer required for precise and approximate measurements, explains the principles on which they work, and describes how to use and calibrate the instruments.

Reinforced Concrete Flats in South London.

At Clarence Avenue, Wandsworth, four six-story blocks of flats of reinforced concrete construction are being erected for the London County Council. Two of the blocks are 194 ft. long by 34 ft. wide and two are 154 ft. by 28 ft.; in each case the story-height from floor to floor is 8 ft. 6 in. and the height from the ground floor to the roof is 51 ft. One of the larger buildings contains 41 flats and the other 40 flats and a laundry; each of the smaller buildings contains 34 flats. One of the larger blocks is shown in *Fig.* 1 during construction.

Fig. 1.—Tower Crane Hoisting a Shutter.

The structures comprise reinforced concrete load-carrying walls; the external walls are 7 in. thick and the party walls and walls surrounding the lift-wells and stair-wells are 6 in. thick. The partitions are of 2-in. clinker blocks. The 4½-in. floors are cast in situ, and where load-carrying walls do not occur the floors are supported by reinforced concrete beams which in general are placed under the partitions. Both precast and in-situ beams are used and are supported either by the walls or by in-situ columns. The stair flights are precast and the landings cast in situ. The flat roofs are 4½ in. thick and covered with a layer of sand ½ in. thick, 2-in. hollow clay blocks, a 2-in. thickness of sand-cement mortar, and ¾ in. of asphalt. The sub-soil is clay and the foundations are generally strip footings under the walls and rectangular bases under the columns.

The external walls are cast in outer shutters, one story high, comprising timber frames lined with plywood, and inner shutters of timber frames lined with wood-wool slabs which form an insulating face to the wall and were subsequently plastered. The outer faces are rendered with coloured cement mortar applied with a machine. Shutters for the ground-floor walls are shown in *Fig.* 2. The lengths of

the shutters are determined, having regard to the fenestration, so that there can be the greatest number of re-uses. Electrically-operated tower cranes travelling on a wide-gauge track are used to move the shutters from one position to another. These cranes have a reach of 65 ft. and a maximum lifting height of 120 ft. The walls are designed for a maximum stress of 760 lb. per square inch in direct compression and are reinforced with two layers of bars near each face. The vertical reinforcement comprises ⅜-in. bars at 12-in. centres, with extra bars horizontally over openings and short bars diagonally at the corners of openings.

Chimney stacks are in reinforced concrete and the flues are lined with fireclay pipes fixed in the shuttering before the concrete is placed. Window and door frames are fixed by means of a "gun" (*Fig.* 4) which pierces the frame and drives a stud into the concrete, thus dispensing with wooden plugs and avoiding the difficulty of aligning the plugs with holes in the frames.

The precast beams are cast on the site in lengths which allow a gap of 1 in. between the ends of the beams and the supporting members. The ends of the beams are serrated and the reinforcement projects as shown in *Fig.* 3. The stair

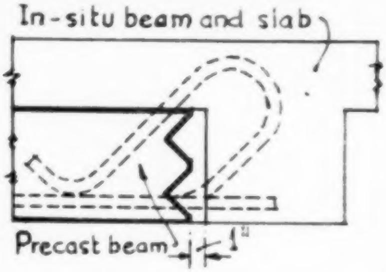


Fig. 3.—Detail of Fixing Precast Beam.

flights are also cast on the site, with 7, 8, or 13 treads, on their sides, with reinforcement projecting at the ends. The precast beams and stairs are hoisted into position by the tower cranes and are propped until the concrete of the supporting members can support them. The floors and roofs are cast on extensible steel centres.

The concrete throughout the work is a 1 : 2 : 4 mixture with coarse aggregate of ¾ in. maximum size. The cement is delivered loose in vehicles carrying two cylindrical tanks, each with a capacity

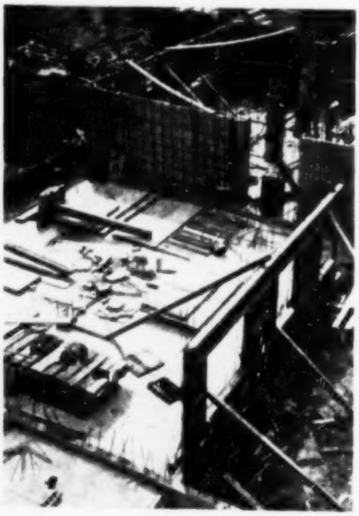


Fig. 2.—Wall Shutters at Ground-floor Level.

Fig. 4.—Fixing Window Frames to Concrete Jambs.

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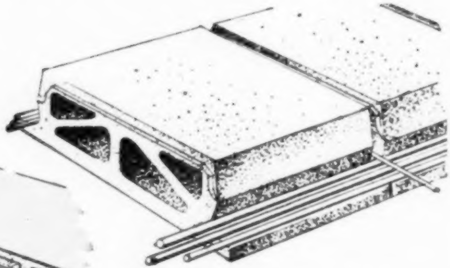
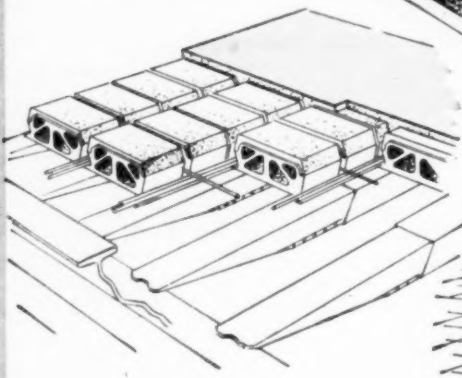
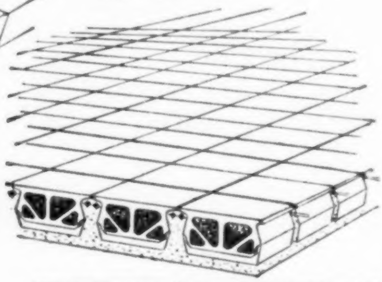


Showing Two-way Reinforcement and Hollow Concrete Blocks laid on Trianco Telescopic Centers.



Showing uniform concrete soffit. Obtained without use of slip tiles.



BUILDING EXHIBITION
Nov. 18th - Dec. 2nd
OLYMPIA - LONDON
STAND No. 294/5 Row P

2 WAY REINFORCED SUSPENDED CONCRETE FLOORS

The Two-way Reinforced Floor for distribution of point loads with efficiency and economy, employing the original system of steel Telescopic Centers.

Midland Associated Company & Licensees,
PARKFIELD CONCRETE PRODUCTS COMPANY LIMITED,
St. Peter's Road, NETHERTON,
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SMITH'S FIREPROOF FLOORS LTD
IMBER COURT · EAST MOLESEY · SURREY
EMBerbrook 3300 (4 lines)

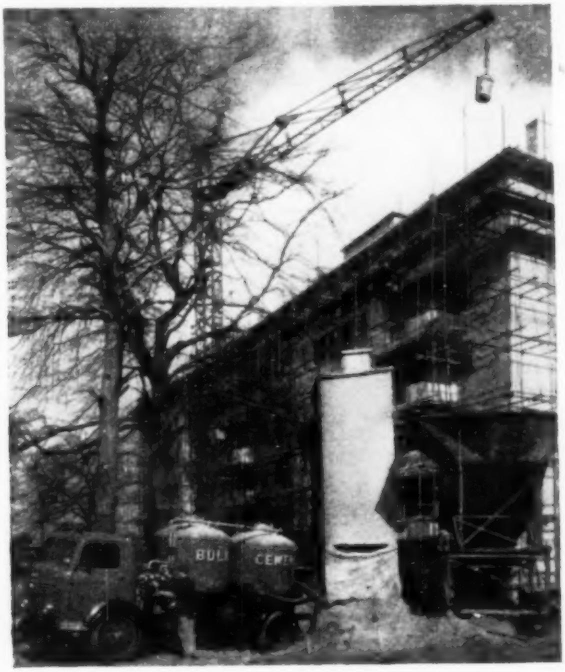

Fig. 5.—Discharging Loose Cement to Timber Silo.

of $2\frac{1}{2}$ tons, and is discharged by pneumatic pressure into timber silos with a capacity of about 18 tons (*Fig.* 5). A weigh-batching plant is used and the concrete is discharged from the mixers into skips which are hoisted by the tower cranes to the shutters.

It is anticipated that the four buildings will be completed by December, 1953; the superstructure of the first of the smaller buildings was completed in five months. The estimated cost of the four blocks is £294,200.

The aggregates, and also the loose cement and the cement silo, were supplied by Messrs. Hall & Co., Ltd. The general contractors for the work are Messrs. Wates, Ltd.

The reinforced concrete was designed (to accord with plans and elevations supplied by the London County Council) by Mr. W. V. Zinn, B.Sc., M.I.C.E., in conformity with the London Building Act (Amendment Act), 1953. The contract is being carried out for the London County Council (Director of Housing and Valuer, Mr. Cyril H. Walker, O.B.E., M.C., F.R.I.C.S., F.R.I.B.A.; Architect of the Council, Dr. J. L. Martin, M.A., Ph.D., F.R.I.B.A.).

Films on Prestressed Concrete.

Two films on the Freyssinet system of prestressing have been made, and are available, with lecture notes, from Diana Wyllie Filmstrip Production, 18 Pont Street, London, S.W.1. One film deals with the equipment and methods used in this system and the other describes the development and application of the system. The price of the films is £1 1s. each.

A Cylindrical Prestressed Concrete Tank.

A PRESTRESSED concrete tank described in a recent number of the French journal "La Technique Moderne" is stated to be the first constructed using a bonded wire system. The tank has a capacity of 772,000 gallons and is to be used for storing petrol.

The tank has an internal diameter of 78 ft. 9 in., the wall is 25 ft. 6 in. high with a thickness of 5·1 in., and the roof is a dome, 5·1 in. thick, with a rise of 7 ft. 10 in. The floor is $4\frac{3}{4}$ in. thick and falls 1 in. in 8 ft. towards a central sump (*Fig.* 1). It was cast on a layer of plain concrete on about 2 ft. of compacted sand. Around the perimeter of the floor, and retaining the sand, is a reinforced concrete beam 3 ft. 3 in. deep by 1 ft. $7\frac{1}{2}$ in. wide which forms the foundation of the wall.

The floor is prestressed by 220 small-diameter wires, tensioned before casting the concrete, radiating from a steel ring surrounding the sump (*Fig.* 2) and anchored to the foundation beam. The floor was cast in one operation.

The Wall.

The wall is prestressed by six rings each comprising a diamond-shaped mesh of small diameter wires which follow the generating lines of a hyperbola within the inner third of the thickness of the wall, thus producing in the concrete a horizontal and a vertical stress perpendicular to the radii of the tank. The rings are 4 ft. 3 in. high and each is designed to resist the pressure of water at a corresponding height. The concrete was cast in rings, of the same height as the meshes, in steel shutters supported by a structural steel frame. Each ring of mesh, except the lowest, is connected to the one below by 1-in. diameter bolts, the lowest ring being anchored by wire ties to the foundation beam. The prestressing force was applied to each mesh by $1\frac{1}{2}$-in. diameter threaded rods attached to the top of the mesh and tensioned by bolts bearing on a horizontal steel member supported by the temporary steel frame (*Fig.* 3). There are 432 rods, each tensioned to 10 tons, creating in the concrete a circumferential compressive stress of 1140 lb. per square inch and a vertical compressive stress of 570 lb. per square inch. When the tank is filled these stresses are reduced to about 142 lb. per square inch.

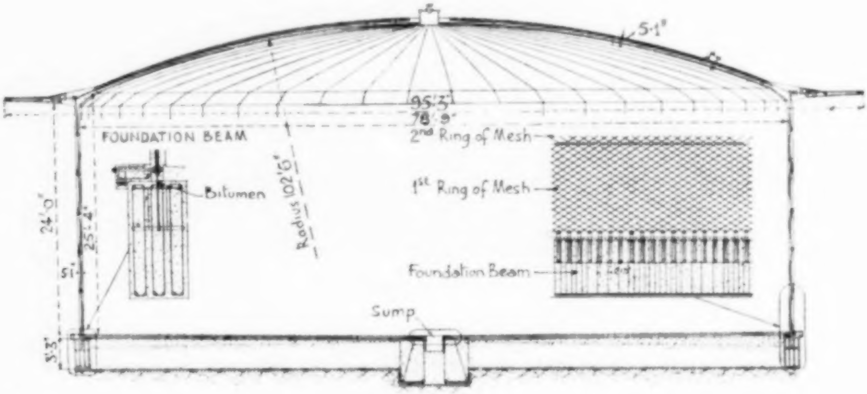

Fig. 1.—Cross Section through Tank.

The Dome.

The dome has to resist an internal pressure of 205 lb. per square foot and is prestressed. The dome was cast in two layers each about $2\frac{1}{2}$ in. thick. After the first layer had hardened the prestressing wires were laid on its upper surface; these were, however, not tensioned until

after the tie-beam was constructed. The tie-beam was prestressed by 28 wires which were tensioned against the shutters, at 300 points around the circumference of the tie. After the concrete was cast the wires were released, creating an internal circumferential force of 100 tons in the

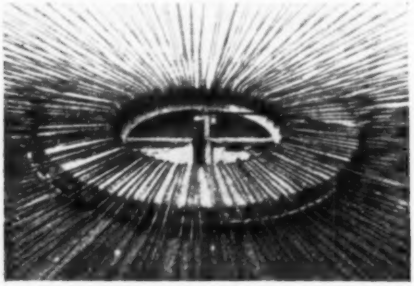

Fig. 2.—The Anchor for the Wires at the Sump.

beam. This was sufficient to resist the thrust due to the weight of the dome, the superimposed loads, and an internal suction equivalent to 41 lb. per square foot. Immediately the tie-beam was prestressed the wires in the dome were tensioned and anchored to the part of the slab already cast, the second layer of concrete then being placed.

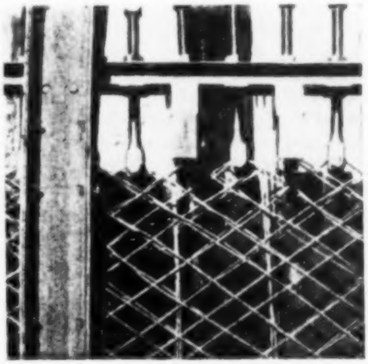

Fig. 3.—Bolts for Tensioning the Mesh in the Walls.

The quantities of material contained in the tank are: 347 cu. yd. of concrete, 12 tons of high-tensile steel, and 8 tons of mild steel. The tank, which is known as a "Weinberg" tank, was constructed by Entreprises Truchetet et Tansini.

Drawing-office Practice.

A REVISED edition has recently been published of the British Standard entitled "Drawing Office Practice for Architects and Builders" (No. 1192, 1953, price 7*s*. 6*d*. from the British Standards Institution). Recommendations are given on the sizes of drawings, drawing-boards, scales, methods of projection, numbering of drawings, the selection of tracing paper and cloth, and the reproduction of drawings. Lists of symbols and abbreviations are given with notes on hatching and colouring for the representation of materials.

Testing Stabilized Soils.

A BRITISH STANDARD entitled "Methods of Test for Stabilized Soils" (No. 1924, 1953, price 12*s*. 6*d*. from the British Standards Institution) contains details of tests for determining the moisture content, dry density, the relationship between the dry density and the moisture content, the unconfined compressive strength, and the cylinder-penetration ratio for soils that have been stabilized by controlling the grading or by the addition of materials such as cement, lime, bitumen, resin, or aqueous solutions of chemicals. Methods for the preparation of samples for testing are also given. Different methods are described for testing fine-grained, medium-grained, and coarse-grained soils, and an appendix contains forms for recording and calculating the results of the tests.

Lectures on Prestressed Concrete.

A COURSE of lectures on prestressed concrete will be given at the London County Council Brixton School of Building on Wednesday evenings from October 7, 1953, to Easter, 1954, by Dr. P. W. Abeles and Mr. J. M. Jagger, and will include demonstrations. Tutorial classes in connection with the lectures will be held on Monday evenings commencing October 19. The fees are £3 5s. for the lecture course and £1 4s. for the tutorial course (£4 4s. for the two courses taken together). The courses are for those who have reached graduate standard in the theory of structures and are experienced in the design of reinforced concrete. Further particulars may be obtained from the Secretary of the School, Ferndale Road, London, S.W.4.

British Standards Institution.

THE address of the British Standards Institution is now 2 Park Street, London, W.1 (telephone Mayfair 9000).

Canadian Conference on Prestressed Concrete.

IT is proposed to hold a conference on prestressed concrete in Toronto on January 28 and 29, 1954. Further information can be obtained from Mr. H. Fealdman, The Hydro-electric Power Commission of Ontario, 620 University Avenue, Toronto 2, Canada, who is the secretary of the organising committee.

MISCELLANEOUS ADVERTISEMENTS.

Situations Wanted, 3d. a word: minimum, 7s. 6d. Situations Vacant, 4d. a word: minimum 10s. Other miscellaneous advertisements, 4d. a word: 10s. minimum. Box number 1s. extra. The engagement of persons answering these advertisements is subject to the Notification of Vacancies Order, 1952.

Advertisements must reach this office by the 23rd of the month preceding publication.

SITUATIONS VACANT.

SITUATIONS VACANT. Reinforced concrete engineers require designer-draughtsmen, preferably A.M.I.Struct.E., for work at Bristol or near London. Opportunity to widen experience. Good salary to right men. Box 3648, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Old-established Tees-side firm requires section leader reinforced concrete designer-draughtsman, fully experienced in designing and detailing reinforced concrete structures, foundations, and other civil work. Apply, giving full particulars and experience, quoting reference D, to Box No. 3656, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Structural engineering assistant required in consulting engineer's office. Must be experienced and capable of designing and detailing reinforced concrete structures. Apply in writing, stating experience and salary required, to J. H. COOMBS & PARTNERS, Thames Corner, Sunbury-on-Thames.

SITUATIONS VACANT. Designer-draughtsmen required for London office of well-established reinforced concrete engineers. Experience in reinforced concrete frames, floors, roof and staircase construction essential. Progressive post. Pension scheme. Alternate Saturdays free. Write fully experience and salary required. Box 3675, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Reinforced concrete designers and detailers, qualified men with at least five years' experience, required for drawing office of reinforced concrete specialists. Apply "TWISTEEL" REINFORCEMENT, LTD., Alma Street, Smethwick.

SITUATIONS VACANT. Clarke, Nicholls & Marcel, consulting engineers, require at their London office reinforced concrete designer-draughtsman and draughtsmen-detailers. Permanent positions, interesting work. Apply in writing, stating age, experience, and salary required, to 21 Westbourne Grove, London, W.2.

SITUATION VACANT. Development engineer required by precast concrete manufacturers for development of reinforced concrete and prestressed concrete products. Qualifications: civil engineering degree, knowledge of mechanical engineering, and practical experience on engineering contracts. Apply, giving details of education and experience, to MANAGING DIRECTOR, JOHN ELLIS & SONS, LTD., 21 New Walk, Leicester.

SITUATION VACANT. Assistant required by consulting engineers. Applicants must be experienced in reinforced concrete; knowledge of structural steelwork an advantage. Apply by letter, stating age, qualifications, and experience, to J. L. WHEELER & JUPP, Empire House, St. Martins le Grand, London, E.C.1.

SITUATION VACANT. Reinforced concrete detailer-draughtsman, with minimum of three years' specialist experience, required. Apply, giving full particulars, to A. E. BEER, 96 St. George's Square, London, S.W.1. Telephone: Tate Gallery 0488.

SITUATIONS VACANT. THE TRUSSED CONCRETE STEEL CO., LTD., Truscon House, 35–41 Lower Marsh, London, S.E.1, have vacancies in the London Office for a senior designer, two designers, and three designer-detailers with considerable experience in reinforced concrete D.O. work. Five-days' week and pension scheme. Apply in writing to the above address, giving full particulars of age, education, and previous employment.

SITUATION VACANT. Experienced reinforced concrete designer required for work in the project section of a company of reinforced concrete engineers and contractors. Five-days' week and pension scheme. Write, giving full details of age, experience, and qualifications, to Box C.E. 578, c/o 191 Gresham House, London, E.C.2.

SITUATIONS VACANT. Consulting engineers require designer-draughtsmen with experience in reinforced concrete work. Salary in accordance with qualifications and experience. Applicants should be Graduates of either the Institution of Civil or Structural Engineers. Apply in writing to ANDREWS, KENT & STONE, 60–66 Wardour Street, London, W.1.

SITUATION VACANT. Consulting structural engineer, Westminster, requires experienced reinforced concrete draughtsman-detailer. High salary and good prospects for suitable applicant. Write, stating age, qualifications, and full details of experience. Box 3679, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Draughtsman with at least three years' experience in reinforced concrete detailing required immediately. Apply in writing only to PETER LIND & CO., LTD., Romney House, Tufton Street, Westminster, S.W.1, stating age, experience, and salary required.

SITUATIONS VACANT. The PORT OF LONDON AUTHORITY invite applications for a number of positions as Civil Engineering Draughtsmen at the following scales of pay, inclusive of pay supplement. The increments are annual, and commencing salaries within the scales are fixed according to qualifications and experience. (a) 1st Class: £602 10s. by £26 5s. to £733 15s. per annum. (b) 2nd Class: £528 by £22 and £21 to £571 per annum. (c) 3rd Class: £407 by £16 10s. to £440, then by £22 to £484 per annum. Applicants should have experience in the following: For (a)—the design and detailing of reinforced concrete, steel, and timber structures. For (b) and (c)—detailing such structures with or without supervision. In all cases maritime works' experience and ability to make site surveys would be an advantage. Applications, giving age, experience, and indicating the position desired, to the ESTABLISHMENT OFFICER, PORT OF LONDON AUTHORITY, Trinity Square, London, E.C.3. Engagement is subject to the provisions of the Notification of Vacancies Orders, 1952.

SITUATION VACANT. Experienced engineer required for London office of reinforced concrete designers. Salary £1,000 p.a., or according to experience. Write, with particulars, to Box N. 462, c/o STREETS, 110 Old Broad Street, London, E.C.2.

SITUATION VACANT. Reinforced concrete engineers require section leader with first-class experience in the design of all types of reinforced concrete structures. The vacancy is in London. Five-days' week and pension scheme. Apply in writing, giving full particulars of age, experience, and qualifications, to Box C.E. 630, 191 Gresham House, London, E.C.2.

SITUATION VACANT. Young assistant to works manager required in concrete department, preferably with civil or structural engineering training. Apply in confidence, with details of previous experience and copies of references, to MANAGING DIRECTOR, THE CROFT GRANITE, BRICK & CONCRETE CO., LTD., Croft, Leics.

SITUATIONS VACANT. Two reinforced concrete detailer-draughtsmen required for design office. Experience on multi story frames or industrial structures an advantage. Write, giving particulars of age, experience, and salary required, to G. A. DODD & PARTNERS, 17–18 Railway Approach, London Bridge, London, S.E.1.

LINDSEY COUNTY COUNCIL, HIGHWAYS DEPARTMENT. *Permanent Staff Vacancies*: (1) BRIDGES ASSISTANT; (2) ENGINEERING ASSISTANT. (1) Experience of bridge and structural design essential. Salary A.P.T. IV and V, starting on the appropriate step according to experience and qualifications. Graduate preferred but intermediate examination qualification may be accepted. (2) Experience in general engineering and surveying work. Salary A.P.T. IV and V, starting as for post (1). Intermediate examination qualification essential. N.J.C. service conditions. Applications, on forms obtainable from me, must be received by 23rd September, 1953. C. K. TALLACK, A.M.I.C.E., County Surveyor, County Offices, Newland, Lincoln.

(*Continued on page lxxii.*)

MISCELLANEOUS ADVERTISEMENTS.

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